PROCEEDINGS

53. IWK

Internationales Wissenschaftliches Kolloquium
International Scientific Colloquium

Faculty of
Mechanical Engineering

PROSPECTS IN MECHANICAL ENGINEERING

8 - 12 September 2008

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http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

Published by
Impressum

Publisher Herausgeber	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Dr. h. c. Prof. h. c. Peter Scharff
Editor Redaktion	Referat Marketing und Studentische Angelegenheiten Andrea Schneider Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurz, Univ.-Prof. Dr.-Ing. habil. Rainer Grünwald, Univ.-Prof. Dr.-Ing. habil. Prof. h. c. Dr. h. c. mult. Gerd Jäger, Dr.-Ing Beate Schlütter, Dipl.-Ing. Silke Stauche
Editorial Deadline Redaktionsschluss	17. August 2008
Publishing House Verlag	Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16, 98693 Ilmenau

CD-ROM-Version:

Implementation Realisierung	Technische Universität Ilmenau Christian Weigel, Helge Drumm
Production Herstellung	CDA Datenträger Albrechts GmbH, 98529 Suhl/Albrechts

ISBN: 978-3-938843-40-6 (CD-ROM-Version)

Online-Version:

Implementation Realisierung	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau

Home / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=17534

53rd Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
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Fatigue of PVD Coatings

Introduction

Reduction of friction and wear is a very important objective in the design process of modern tribological systems which is why PVD coatings are becoming more and more popular. Especially carbon based coatings like e. g. Zirconium Carbide are characterized by very low friction coefficients corresponding with high wear resistances. Whereas friction and wear properties of these PVD coatings can be assessed directly in test rig investigations, the calculation of admissible fatigue stresses requires numerical simulations of representative tests. [1], [2]

Test Procedure

The institute for machine elements and machine design, which belongs to the faculty of mechanical engineering of the RWTH Aachen, performs a so called surface fatigue test in which a PVD coated disc and a SiN ball are in contact. The steady state cyclic loading causes both plastic deformation of the substrate material of the disc and cyclic tension stress in the PVD coating which results in fatigue failure. This can be detected in microscopic investigations.

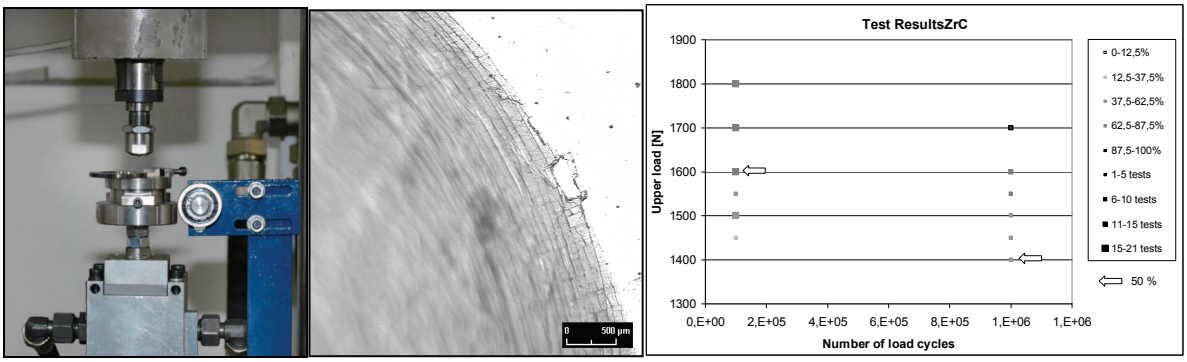

Figure 1: Test rig, specimen with cracks, test results

Tests are made with different loads both for 10^5 and 10^6 load cycles each. Since the stressed volume in this test procedure is very small, the results are affected by a considerable statistic variance which leads to a large number of necessary tests. The

results in Figure 1 illustrate the statistic influence and also the high load sensitivity, which is typical for PVD coatings.

Finite Elements Analysis

Numerical simulations with the Finite Elements Method of this test procedure make it possible not only to understand the microscopic damage processes but also to calculate the failure stresses corresponding to the failure load, which is necessary to identify the admissible loadings of PVD coated components. These simulations have to consider nonlinear effects like plasticity, strain hardening and contact. The simulation results in Figure 2 show the stress amplitude of 950 MPa, which causes failure with a probability of 50 % after 10^6 load cycles.

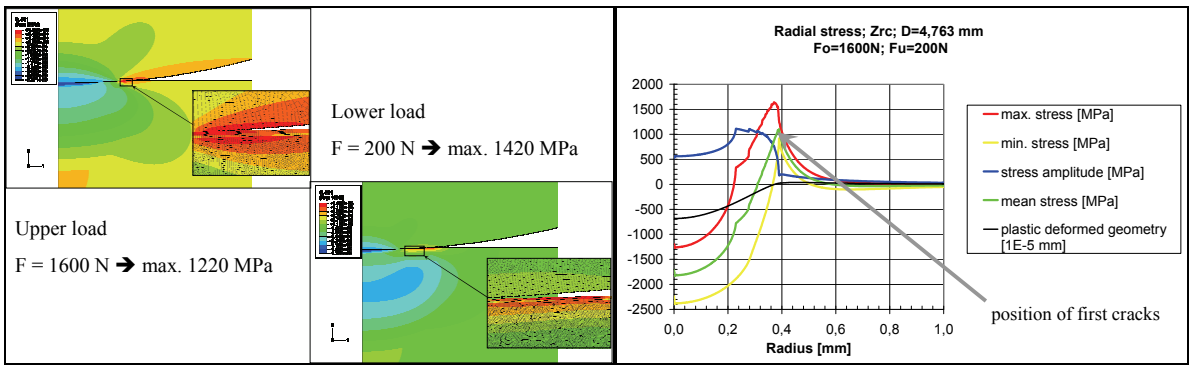

Figure 2: Finite Elements results

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47. Tribologie-Fachtagung, GfT, Göttingen, 2006

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